

## Full Length Research Paper

# Ecological properties of some *Crocus* taxa in Turkey

Levent Şik\* and Feyza Candan

Department of Biology, Science and Art Faculty, Celal Bayar University, Muradiye-Manisa/Turkey.

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**In this study, ecological properties of the areas where some *Crocus* taxa (*C. ancyrensis*, *C. sieheanus*, *C. chrysanthus*, *C. flavus* subsp. *flavus*, and *C. flavus* subsp. *dissectus*) grow naturally was considered. The plants together with *in situ* soil samples were collected in their flowering periods and data on the distribution areas of the plants and some physical and chemical properties of soil samples were determined. In conclusion, the properties of the new distribution areas for the taxa have been presented and it has been observed that taxa usually grow in light alkali, non-salted, clayey-loamy soils.**

**Key words:** *Crocus* spp., ecological properties, Turkey.

## INTRODUCTION

*Crocus* L. (Iridaceae) has approximately 86 species and 132 taxa, most of them are native to Mediterranean area. It can be found from Portugal and Morocco in the west to Kyrgyzstan and Shenyang provinces of Western China, and Ala Tau and Tien Shan Mountains of Mongolia in the East. Most of the taxa collected are located in the Balkans and Turkey. The distribution range of the species is from 10° west longitude to 80° east longitude and 30° north latitude to 50° south latitude (Mathew, 1982).

There are 35 species of *Crocus* in Turkey. The number of taxa increases up to 70 when the subspecies of these species are considered. When the diversity of the taxa is taken into consideration, Turkey is regarded as the gene center of this particular species (Mathew, 1982; 1984; 2000a; Kerndorff and Pasche, 2004a, b, 2006). Many members of the species play an important role in floral arrangements in park and garden especially in European countries (Bowles, 1954; Mathew, 2000b; Goode, 2005). According to Cebeci and Erol (2007), *C. graveolens* is attractively colored and shaped flower and it has distinctive horticultural advantages in low altitude coastal zones. Therefore the ecological requirements of the plant is of importance. There was no detailed study available. According to some studies, only bedrock preferences were explained (Bowles, 1954; Mathew, 1982). As a result, in this study, some ecological properties of the regions where *Crocus* taxa distributed are studied.

## MATERIALS AND METHODS

The material includes soil samples taken from the regions where taxa of *Crocus ancyrensis* (Herbert) Maw, *C. sieheanus* Barr ex Burt, *C. chrysanthus* (Herbert) Herbert, *C. flavus* Weston subsp. *flavus*, *C. flavus* subsp. *dissectus* T. Baytop and Mathew are distributed. The samples collected between 2003 and 2006, during flowering period and were classified according to Mathew (1984; 2000a). 1 kg of soil samples was taken after the surface ground was cleared from the top layer to depth of 0 - 20 cm. The physical and chemical (pH, salinity, CaCO<sub>3</sub>, texture, N, P, K, Ca, Mg, Fe, Cu, Zn, Mn and Na) analyses of the soil samples were conducted in the Soil Analysis Laboratory of Manisa Tarım İl Müdürlüğü using standard methods (Öztürk et al., 1997). The results of the analyses were evaluated in accordance with the standard data (Anonymous, 1954; Kovancı, 1969; Öztürk and Görk, 1979; Özdemir and Öztürk, 1996; Öztürk et al., 1997; Tarımcılar and Kaynak, 2000).

## RESULTS

### The distribution of the taxa and the properties of the distribution areas

The localities of the study samples and their characteristics are shown in Table 1. The plants were collected from Bolu, Çanakkale, Izmir, Manisa, Denizli and Adana all of which have a continental climate.

According to Mathew (1982), *C. ancyrensis* is endemic for Turkey and distributed at an altitude of 1100 m 2 km away from Abant to Mudurnu (Bolu); at 1350 m between Gerede and Kızılcahamam (Ankara); at 1550 m in Ilgaz Mountain (Kastamonu); at 1800 m Keltepe (Zonguldak); 26.5 km to the northeast of Sungurlu (Çorum); at 1400 m

\*Corresponding author. E-mail: [levents@bayar.edu.tr](mailto:levents@bayar.edu.tr). Tel.: +902362412151.

**Table 1.** Localities where the material was taken and the characteristics of these localities (A: *Crocus ancyrensis*; S: *C. sieheanus*; C: *C. chrysanthus*; F: *C. flavus* subsp. *flavus*; D: *C. flavus* subsp. *dissectus*).

Localities	<b><i>C. ancyrensis</i> (Herbert) Maw</b>
A1	Bolu: Abant Lake-road of Mudurnu, around Çepni village, 1048 m, 20.03.2004. together with <i>Verbascum</i> sp., opened places of <i>Pinus brutia</i>
A2	Bolu: Bolu- road of Gerede, 13 km to Gerede, around Kayıkiraz village, 1190 m, 09.04.2005, together with <i>Verbascum</i> sp., stony slopes
A3	Bolu: Kırırsçık- road of Bolu, 10 km to Bolu, 1485 m, 09.04.2005, together with <i>Crocus biflorus</i> subsp. <i>pulchricolor</i> , <i>Cyclamen</i> sp., <i>Muscari</i> sp., under and opened places of <i>Pinus brutia</i> and <i>Pinus sylvestris</i>
A4	Bolu: 30 km to Seben, Karacasu plateau, Beşpınarlar recreation spot, 1485 m, 10.04.2005, together with <i>Crocus biflorus</i> subsp. <i>pulchricolor</i>
A5	Bolu: Towards Ankara 25 km to Kızılcahamam, Yünlü plateau, 1330 m, 10.04.2005, together with <i>Crocus biflorus</i> subsp. <i>pulchricolor</i> and <i>Verbascum</i> sp.
	<i>C. sieheanus</i> Barr ex Burt
S1	Adana: Pozantı, Aladağlar, Fındıklı village, Elma Sekisi region, 1510 m, 27.03.2005, opened places of <i>Cedrus libani</i> and <i>Pinus nigra</i> , opened slopes
	<i>C. chrysanthus</i> (Herbert) Herbert
C1	Manisa: Spil Mountain, upper of Turgutalp village, 998 m, 24.02.2005, <i>Sarcopoterium spinosu</i> , <i>Galanthus elwesii</i> , <i>Verbascum</i> sp., opened places of <i>Pinus nigra</i> .
C2	Manisa: Spil Mountain, around Atalanı and lake, 1100 m, 24.02.2005, together with <i>Colchicum triphyllum</i> , under and opened places of <i>Pinus nigra</i>
C3	Manisa: Spil Mountain, Atalanı, 1200 m, 06.03.2005, under and opened places of <i>Pinus nigra</i> , together with <i>Muscari</i> sp.
C4	Manisa: entrance of Maldan village, Kuyular region, 52 m, 09.02.2005, together with <i>Crocus fleischeri</i> , opened places of <i>Pyrus amygdaliformis</i>
C5	Manisa: from Manisa to Maldan Köyü 4 km, right slopes, 360 m, 09.02.2005, together with <i>Crocus fleischeri</i> , under and opened places of <i>Quercus coccifera</i>
C6	Manisa: Avdal village, near of bridge, right slopes, 126 m, 24.02.2005, under and opened places of <i>Pinus brutia</i>
C7	İzmir: Kemalpaşa, Nif Mountain, 9 km to Kemalpaşa, right slopes, 785 m, 26.02.2005, under and opened places of <i>Pinus brutia</i>
C8	İzmir: Yamanlar Mountain, 7 km. to Karagöl, left slopes, 700 m, 01.03.2005, under <i>Platanus orientalis</i> opened places
C9	Kütahya: 10. km of Kütahya-Afyon, right of road, 1113 m, 18.03.2005, under <i>Quercus coccifera</i> and <i>Phylleria latifolia</i>
C10	Kütahya: road of Uşak-Aslanapa, next 13 km. from Gediz, 1185 m, 18.03.2005, opened places of <i>Pinus nigra</i> , steep slopes
C11	Adana : Pozantı, Aladağlar, Kamışlı village, Kirazoluğu region, 1362 m, 26.03.2005, <i>Cedrus libani</i> and under and opened places of <i>Pinus nigra</i> , opened stony slopes
C12	Adana: Pozantı, Aladağlar, Kamışlı village, Sıyırma region, 1555 m, 26.03.2005, opened places of <i>Cedrus libani</i> and <i>Pinus brutia</i> , opened stony slopes
	<i>C. flavus</i> Weston subsp. <i>flavus</i>
F1	Çanakkale: road of Ayvacık-Ezine, around of Çarıksız village, 160 m, 20.03.2005, under <i>Quercus coccifera</i> and <i>Phylleria latifolia</i>
F2	Çanakkale: entrance to Ayvacık from Çanakkale, right of road, 145 m, 19.03.2005, <i>Pinus brutia</i> woodland
F3	Çanakkale : around Truva, Truva'ya 8 km kala, 72 m, 05.03.2005, open stony flat place, under <i>Quercus coccifera</i>
	<i>C. flavus</i> subsp. <i>dissectus</i> T. Baytop & Mathew
D1	Manisa: Kırkağaç, Çamlık recreation spot, 240 m, 17.03.2005, <i>Pinus brutia</i> woodland
D2	Manisa: road of Akhisar-Sındırgı, around of Muştular village, 210 m, 16.03.2005, open flat place, under <i>Quercus coccifera</i>
D3	Denizli: road of Denizli-Tavas, Çukurköy, Cankurtaran region, 1040 m, 10.03.2005, <i>Pinus nigra</i> , silviculture field
D4	Balıkesir: road of Balıkesir-Bigadiç, around of Çağış village, 10.03.2005, under <i>Quercus coccifera</i>

in Degirmendere Plateau, (Akdağ-Amasya); Tavşan Mountain (Samsun); at 1000 - 1200 m near Merzifon, and in Ahır Mountain (Kahramanmaraş). *C. sieheanus*, another endemic species for Turkey, is found at 1500 m in Misli (Niğde) at 2000 m in Kızılpınar Plateau (Aydos, Ereğli, Konya), and at 2000 m in Hamidiye Village (Kamışlı, Pozantı, Adana). *C. chrysanthus*, shows an interesting large variation in terms of its morphological, anatomical, cytological, palinological and seed micromorphological characteristics (Candan, 2007). It is distributed at 50 m between Keşan and Enez (Edirne); at 1100 m Uludağ (Bursa); at 1450 m in Bozdağ (Izmir); at 1350 m in Aslanapa (32 km away from Kütahya); at 2200 m in Konya (11 km to the southwest of Akşehir; Bakırdağ (Kayseri); near Göksun (Kahramanmaraş), at 1500 m to the northwest of Maraş; Göktepe (Muğla); at 1100 – 1200 m, to the north of Gencek (Konya); near Gündoğmuş (Antalya); near Ulukışla (Niğde), and at 1660 m Solak Mountain (Kahramanmaraş). *Flavus*, one of the two subspecies of *C. flavus*, is distributed in Eceabat (Sestus) (Çanakkale); Havsa (Edirne); Hayrabolu (30 km away from Tekirdağ), at 350 m in Kurudağ (Çanakkale); Aydos Mountain (Istanbul); Uludağ (Bursa), and Truva (Çanakkale), around Kurşunlu Tepe. *Dissectus* another subspecies of *C. flavus* is endemic and mostly found at 545 m between Edremit and Balıkesir; Bigadiç (Balıkesir); at 1200 m in Murat Mountain (Kütahya).

#### Soil Characteristics of *C. ancycrensis*

Soil samples of this species were taken from five different locations (A1, A2, A3, A4 and A5) in Bolu. The pH value of the soil varies from between 6.57 and 7.91. The soil is moderately (slightly) acidic and alkali. Salinity content of the soil is very low (227 - 510  $\mu\text{S}/\text{cm}$ ).  $\text{CaCO}_3$  content of the soil varies from between 1.24 and 8.26%. The soil has the characteristics of soil with a low or medium level of  $\text{CaCO}_3$ . The  $\text{CaCO}_3$  content of A1 and A5 locations is higher than that in A2, A3 and A4 locations. The texture of the soil is clayey-loamy and loamy. The N content of the soils varies from between 1.51 and 7.7 ppm. The soils are poor in nitrogen. The P contents of the soils are generally high (3.45 - 16.01 ppm). The K contents of the soils are usually adequate (153 - 215 ppm). The Ca values vary from between 3157 and 3569 ppm, and are present at adequate levels in all of the soil samples. The Mg exists in all of the soil samples at sufficient levels (205 – 402 ppm). The soils have enough amounts of Fe (12.72 – 34.63 ppm), Cu (0.65 – 3.33 ppm), Zn (0.87– 4.46 ppm) and Mn (4.79 – 17.5 ppm). The Na rates are very high (12 - 43 ppm) (Table 2).

#### Soil characteristics of *C. sieheanus*

It is not a widely distributed species and its soil Characteristics are based on only one locality (S1) in

Adana. The soil characteristics of this locality and distribution are as follows: neutral pH (6.98), poor in salinity (586  $\mu\text{S}/\text{cm}$ ) and  $\text{CaCO}_3$  (0.62%), clayey-loamy. As it is seen in Table 2, the N value is insufficient (3.9 ppm); the Na value is very high (47 ppm); K (184 ppm), Fe (10.8 ppm), Cu (2.2 ppm) and Mn (15.4 ppm) values are sufficient. While P (3.68 ppm) value is moderate; Zn (1.15 ppm), Mg (204 ppm) values are at good levels; the Ca at a rate of (3250 ppm) is high (Table 2).

#### Soil characteristics of *C. chrysanthus*

Soils for *C. chrysanthus* were obtained from 12 localities (C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11 and C12) and characteristics of the soils are as follows: moderate (slightly) acidic and alkali. The  $\text{CaCO}_3$  content of the soil samples varies from between 0.23 and 12.48%. While the soils in C1, C2, and C3 locations are calcareous; in other locations the soils are clayey-loamy. The N content measures between 2.52 and 7.68 ppm and they are poor in nitrogen. The P values change between 2.32 and 43.18 ppm, and are at moderate levels in 50% of the locations. The K content of the soils is usually at sufficient levels (103 – 372 ppm). The Ca levels changes between 2897 and 4258 ppm, and are very high in locations of C3, C7 and C9 but higher in other locations. The Mg values are at good levels in all locations (148 - 451 ppm). Fe (8.5 – 57.6 ppm), Cu (0.4 – 11.7 ppm), Mn (3.4 – 48.96 ppm) and Zn (0.32 – 8.21 ppm) values are at sufficient levels in all locations. The Na values vary between 9 and 61, which are considered very high (Table 2).

#### Soil characteristics of *C. flavus* subsp. *flavus*

Soil characteristics of this taxon are based on the samples taken from 3 different locations (F1, F2 and F3). The pH values vary from 6.58 to 7.35 ppm. The soils are slightly acidic and alkali with a very low salinity content (228 – 665  $\mu\text{S}/\text{cm}$ ). The levels of the  $\text{CaCO}_3$  content of the soils are very low (0.23 - 0.85%) and they have a clayey-loamy structure. While the N values are between 2.45 and 4.96 ppm, the Na values vary from between 38 and 57 ppm. The soil samples are rich in nitrogen but poor in sodium and also in P (0.5 – 1.78 ppm) and Zn (0.18 – 0.88 ppm). K (137 – 287 ppm) and Cu (0.8 – 1.23 ppm) values are sufficient in all locations. The Fe content (1.96 – 8.3 ppm) is at sufficient level in all locations except in the locality of F3. The Mn (0.65 – 2.1 ppm) level is sufficient in F2 but insufficient in the other two localities. Whereas the Ca (3158 – 3569 ppm) contents of the soil samples are high in all the localities, the Mg (199 – 259 ppm) level is satisfactory (Table 2).

#### Soil characteristics of *C. flavus* subsp. *dissectus*

The soil samples for the taxa were taken from 4 different

**Table 2.** Physical and chemical characteristics of soil samples.

Code	pH	Salinity ( $\mu\text{S/cm}$ )	$\text{CaCO}_3$ (%)	Texture	N (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Fe (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Na (ppm)
A1	7.13	251	3.51	clayey-loamy	2.35	13.01	171	3545	356	23.30	0.65	2.82	17.5	12
A2	6.67	510	1.24	clayey-loamy	1.51	3.45	153	3267	312	14.73	2.31	0.87	4.79	41
A3	7.91	508	1.87	clayey-loamy	7.7	16.01	165	3569	248	18.3	1.2	1.69	17.5	22
A4	6.57	227	1.79	loam	1.81	12.27	215	3214	205	34.63	3.33	1.98	5.01	18
A5	7.62	422	8.26	loam	2.1	8.28	199	3157	402	12.72	2.99	4.46	6.33	43
S1	6.98	586	0.62	clayey-loamy	3.9	3.68	184	3250	204	10.8	2.2	1.15	15.4	47
C1	6.96	1648	12.48	clayey-loamy	5.27	43.18	208	3247	356	28.83	4.79	8.21	48.96	15
C2	6.38	334	0.39	clayey-loamy	5.38	6.18	150	3356	241	30.7	2.2	0.55	12.1	24
C3	7.51	776	6.47	clayey-loamy	2.52	5.59	103	3887	451	24.27	2.36	1.63	8.78	9
C4	6.44	500	0.39	clayey-loamy	4.94	7.88	360	3010	189	15.5	1.4	2.04	20.2	61
C5	6.25	469	0.39	clayey-loamy	5.42	3.83	372	2897	168	8.5	0.4	0.32	12.7	13
C6	6.70	414	0.23	clayey-loamy	4.58	2.32	255	3158	189	22.6	1.4	1.11	3.4	53
C7	7.22	552	0.93	clay	7.68	4.82	296	4258	358	54.9	2.3	2.84	37.3	29
C8	5.85	474	0.39	clayey-loamy	5.5	10.55	180	2897	166	57.6	0.8	2.9	22.2	32
C9	7.85	350	9.33	clay	6.16	3.08	218	4002	402	19.4	3.3	7.38	20.0	21
C10	7.09	301	0.39	clayey-loamy	4.89	5.49	169	2898	296	42.7	2.2	1.42	13.8	17
C11	7.74	530	2.65	clayey-loamy	5.62	3.49	372	3514	148	9.9	11.7	2.55	3.8	20
C12	7.37	233	0.62	loam	4.49	5.58	149	3156	148	15.3	1.5	0.72	3.4	19
F1	6.58	228	0.23	clayey-loamy	4.52	0.77	137	3158	199	8.3	0.8	0.38	1.8	38
F2	7.05	420	0.31	clayey-loamy	4.96	1.78	287	3569	259	6.4	1.1	0.88	2.1	46
F3	7.35	665	0.85	clayey-loamy	2.45	0.5	211	3478	207	1.96	1.23	0.18	0.65	57
D1	7.43	1352	12.87	loam	7.54	2.64	277	3987	388	12.9	3.5	1.36	3.6	22
D2	7.76	546	12.48	clayey-loamy	5.89	2.28	257	4012	450	6.3	6.6	1.93	3.9	30
D3	7.18	904	0.23	loam	2.99	0.47	248	3147	204	4.39	0.51	0.39	0.61	32
D4	7.45	210	11.7	loam	2.18	0.86	60	4021	348	1.59	0.86	0.24	1.56	39

locations (D1, D2, D3 and D4) in Western Anatolia. The soils are slightly alkali (7.18 – 7.76) and not saline (210 – 1352  $\mu\text{S/cm}$ ), and in all the locations soils are calcareous with exception of D3. All the soils have a loamy structure in all of the locations with the exception of D2. Soils are poor in nitrogen (2.18 – 7.54 ppm) but rich in sodium (22 – 39 ppm). Samples are poor in P (0.47 – 2.64 ppm). K (60 – 277 ppm) and Fe (12.9 – 1.59 ppm) contents of the soils are sufficient in all locations except in D4. Cu (0.51 – 6.6 ppm) is sufficient in all locations. Zn values vary from 0.24 to 1.93 and are sufficient in D1 and D2, but poor in D3 and D4. Mn (0.61 - 3.9) is sufficient in D1 and D2 but insufficient in all the other localities. Ca (3147 – 4021 ppm) content of the soils is very high in all the locations except in D3. The level of Mg (204 – 450 ppm) content is good (Table 2).

## DISCUSSION

In this study, some ecological aspects of 5 *Crocus* taxa were considered. For some taxa, new distribution ranges and their characteristics have been given. The soils where the taxa grow have been examined in terms of their physical and chemical parameters.

The *Crocus* taxa mentioned in this study may be said to grow usually in slightly alkali, non-salted, clayey-loamy textured soils. Besides, the soil samples examined draw attention to the fact that they usually have sufficient amount of K, Fe, Cu, Zn, Mn and Mg but too much Ca (Anonymous, 1954; Kovancı, 1969; Öztürk and Görk, 1979; Özdemir and Öztürk, 1996; Öztürk et al., 1997; Tarımcılar and Kaynak, 2000). 21% of all soils in Turkey have very limited amount of nitrogen (Bosgelmez et al., 2001) and it can be said that the *Crocus* taxa grow in soils with too little nitrogen. Moreover, it is pointed out that many species (such as *C. baytopiorum*, *C. vitellinus* and *C. graveolens*) grow even on limestone (Mathew, 1982). It has also been reported that *C. sativus*, which is cultured both in Turkey and across the world, is grown in loose, stoneless argillaceous soil (Vurdu and Güney, 2004). The concentration of lime ( $\text{CaCO}_3$ ) in soils where the taxa in this study grow ranges from 0.23 to 12.87%.

*Crocus* taxa spread out together with different geophytes (*Crocus*, *Muscari* and *Galanthus* species) and other different trees and shrubs such as *Pinus*, *Cedrus*, *Quercus* and *Verbascum* species. *Crocus* species have been used as ornamental plants in such European countries as England and Germany since ancient times

(Bowles, 1954; Mathew, 2000b; Goode, 2005). New hybrids are bred from natural species. Those plants with beautiful flowers are also economically valuable in the ornamental plant market. It would be appropriate to use these plants also as ornamental plant in parks and gardens in Turkey, which is the homeland for *Crocus* species (Mathew, 1982; 1984; 2000a; Kerndorff and Pasche, 2004a; 2004b; 2006). In the view of this point it is necessary to increase the importance of the ecological conditions that these plants need in order for them to thrive. With all this knowledge, some alternative ornamental plants like *Crocus* may be provided for those in gardening and landscape architecture business.

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